Soil Reclamation and Restoration Techniques

Saline Soil Reclamation and Management

- Saline soils in which the soluble salts contain appreciable amounts of calcium and magnesium do not develop into alkali soils by the action of leaching water. The reclamation is comparatively easy in such soils. The main problem is to leach the salts downward below the root zone and out of contact with subsequent irrigation water.

Following methods may be used for removal of salts

(A) Mechanical Methods:

- (i)Flooding and leaching down of the soluble salts:

The leaching can be done by first ponding the water on the land and lowering it to stand there for a week. Most of the soluble salts would leach down below the root zone. After a week, standing water (dissolved with soluble salts) is allowed to escape. Such, 2 to 3 treatments are given to reclaim highly saline soils. Sometimes gypsum is also added to flood water when the soluble salts are low in calcium to check development of alkalinity.

(ii) Scrapping of the surface oil:

When the soluble salts accumulate on the soil surface, scrapping helps to remove salts. This is a temporary cure and salinity again develops on such lands.

(B)Cultural Methods(Crop, Soli and Water Management):

If the soil is not free draining, artificial, drains are opened or tile drains laid underground to help wash out the salts.

(ii)Use of salt free irrigation water:

Salt free good quality of irrigation water should be used.

(iii) Proper use of irrigation water:

It is known that as the amount of water in the soil decreases the concentration of salts in the soil solution increases, thus, moisture should be kept at optimum field capacity.

(iv) Planting or sowing of seeds in the furrow:

The salt concentration even in smaller amounts is most harmful to the germinating seedlings. Water generally evaporates from the highest surface by capillarity and hence, these points have maximum salt concentrations. If the seeds or seedlings are planted inside the furrows, they escape the zone of maximum salt concentrations and thus, can germinate and develop properly during their early growth stage.

(v) Use of Acidic Fertilizer:

In saline soil, acidic nature of fertilizers (e.g., Ammonium sulphate) should be used.

(vi) Use of organic manures:

The organic manures have very high water-holding capacity. When sufficient amount of these manures are added the water-holding capacity of soil increases and as a result the conductivity of the soil solution decreases.

(vii) Ploughing and leaving of the land:

Ploughing and leveling of the land increases the infiltration and percolation rate. Therefore, salts leach down to the lower levels.

(viii) Retardation of water evaporation from soil surface:

Water may be conserved in the soil retarding the water evaporation. Thus, salts may remain in the lower level with the water.

(ix) Growing of salt tolerant corps:

- (a) High salt tolerant crops: Para grass, barley, sugar beet, etc.
- (b) Moderately salt tolerant crops: Wheat, rice, sorghum, maize, flax etc. (c) Low salt tolerant crops: Beans, radish, white clover etc.
- (d) Sensitive crops: Tomato, potato, onion, carrot etc.

- II . Reclamation and Management of Alkali(Saline-alkali and non-saline-alkali) Soils:
- Alkali soils cannot be reclaimed by mere flooding the land. In the case of saline-alkali soils, flooding is likely to do more harm. Leaching (flooding) down of soluble salts make the soil alkaline (only Na-clay remain in the soil. Soils get dispersed and become compact (impervious).
- In alkali (non-saline-alkali) soils, exchangeable sodium Na-clay is so great as to make the soil almost impervious to water. But even if water could move downward freely in alkali soils , the water alone would not leach out leach out excess these exchangeable sodium . The sodium-cation must be replaced by calcium-cation and then leached downward.

(iii) Addition of organic matter:

The addition of organic matter increases acidity, thus, helping in lowering the pH. Organic matter is especially helpful where sulphur is added to correct the alkalinity. The organic matter supplies food for the bacteria that stimulates the oxidation of sulphur to the sulphate form. The combination of sulphur, organic matter and gypsum has also been used with success.

(iv)Use of sulphuric acid:

Sulphuric acid changes the sodium carbonate to the less harmful sulphate and also tends to reduce the intense alkalinity. It should be used in the presence of calcium carbonate.

$$Na_2CO_3 + H_2SO_2 \longleftrightarrow CO_2 + H_2 + Na_2SO_4$$

Leachable

(v) Addition of molasses:

Addition of molasses in the soil provide the source of energy for microorganism which on fermentation produce organic acids. The organic acids reduce alkalinity.

(vi)Use of Pyrite:

Pyrite is a mineral containing iron and sulphur and generally it has a chemical composition of FeS_2. Pyrite is found all over the world in igneous and metamorphic rocks and at some places as sedimentary deposits as well.

Pyrite is pyrophoric in nature, produces sulphuric acid and iron sulphate on coming in contact with air and water. The sulphuric acid so produced reacts with the native $CaCO_3$ of these soils to produce soluble calcium which then replaces sodium from the exchange complex.

$$2FeS_2 + 2H_2O + 7\ O_2 \longrightarrow 2FeSO_4 + 2H_2SO_4$$

LAND RESTORATION

- Land restoration is the process of ecological restoration of a site to a natural landscape and habitat, safe for humans, wildlife, and plant communities.
- Land restoration is not the same as land reclamation, where existing ecosystems are altered or destroyed to give way for cultivation or construction.
- Land restoration can enhance the supply of valuable ecosystem services that benefit people.

RESTORATION TECHNOLOGY

1. Improvement in soil organic carbon pool

- Crop yields can be increased by 20-70 kg ha*1 for wheat, 10-50 kg ha'1 for rice, and 30-300 kg ha-1 for maize with every 1 Mg ha*1 increase in soil organic carbon pool in the root zone.
- Adoption of recommended management practices on agricultural lands and degraded soils would enhance soil quality including the available water holding capacity, cation exchange capacity, soil aggregation, and susceptibility to crusting and erosion. Increase in soil organic carbon pool by 1 Mg ha 'y ' can increase food grain production by 32 million Mg y 1 in developing countries.

PEATLAND RESTORATION

- Organic or peaty soils accumulated large quantities of carbon due to anaerobic decomposition of the organic matter. Anaerobic decomposition, or decomposition under absence of oxygen, occurs due to the flooded conditions of peatlands.
- When converted to agricultural lands the soils are drained, which removes the anaerobic conditions as it introduces oxygen into the soil.
- This process favours aerobic decomposition (decomposition with oxygen) which results in high CO2 and N20 fluxes (IPCC, 2007).

METHODS USED IN LAND RESTORATION AND REVEGETATION

a) On cultivated land:

1. Agro-silvicultural methods

- These are practiced to restore the soil fertility. The traditional system under rainfed conditions, is to restore the lost fertility through bush fallow system. Vegetation, mainly bushes, colonise the area naturally.

2. Shelterbelts

- These are used to protect both irrigated and rainfed farms. Their main function, at present, is to protect valuable agricultural land and irrigation canals from creeping sands.
- Shelterbelts reduce wind velocity, improve the microclimate and increase yields.
- Field investigations in dry areas show that crop production may be increased by as much as 300% while the increase in average years is often 30 to 50%
- Mostly Eucalyptus, Casuarina sp., populus and prosop is. Seedlings are used for establishment.

3. Plantations on seriously degraded Irrigated or rainfed crop land

- Salinization is of common occurrence in irrigated lands, plantations of eucalyptus were established in some of these degraded lands to bring them back to production.
- The product is to be used to establish wood-based industries.
- Eucalyptus, microtheca_plantations are established on such sites

C) On Bare land: sand and sand-dune fixation:

- When erosion reaches an acute level, and where sand starts to move and threatens habitations, establishments, roads and agricultural land, sand-dune fixation is carried out.
- This occurs along the coasts of seas and oceans or in continental areas.
- The conventional method used is the establishment of hedges of stalks of dry grass and/or bushes to restrain temporarily sand movement until the dunes are planted with trees, shrubs and grasses.
- Eucalypts, pines, and acacias are used.

(ii) Active intervention methods:

- These require the actions of man to restore the degraded land and vegetation.
- A. Sand and sand-dune fixation through artificial sowing of plants including tree, shrub and grass species.
- B. Establishment of shelterbelts on irrigated and rainfed cultivated land, and for protection of habitations and infrastructures.
- C. Establishment of plantations on degraded lands, especially on irrigated degraded lands (salinity and waterlogging). These offer a great potential for generation of wood-based industries in dry lands.
- D. Establishment of tree, shrub and grass plantations of value to restore the fertility of degraded lands where soil fertirainfed cultivation is practiced (use of Acacia and leguminous plants to restore lity).
- E. Seeding and planting catchment areas and banks of permanent and seasonal water-courses for regulation of water-flows and erosion control.

Use of organic farming techniques

Organic farming techniques that help restore the soil include use of green manure (uprooted or sown crop parts incorporated or left on topsoil), cover crops, crop rotation and organic compost.

A) Green manure and cover crops:

- Green manures and cover crops serve as mulch to the soil preventing the soil from wind/water erosion and moisture loss.
- They also increase the soil organic matter content as they decompose in the soil.
- Green manure and cover crops that are legumes (plants which produce seeds in pods) have nitrogen fixing ability. The nitrogen fixing bacteria in their root nodules help capture nitrogen from the atmosphere.
- Green manure and cover crops suppress weed growth.

B) Organic compost:

Compost is a mixture of decomposed plant parts and animal waste.

- The key benefit of composting is that it increases soil organic
- matter content.
- Organic matter improves the soil fertility, the soil structure and its water holding capacity.
- It also sequesters carbon in the soil.

C) Crop rotation: This is a farming practice which involves growing different types of crops in one location sequentially. This practice reduces soil erosion, increases the soil fertility and subsequently crop yield.

D)Soil remediation:

Soil remediation involves the removal of harmful contaminants such as. heavy metals, sewage sludge, coal tar, carcinogenic hydrocarbons, liquors and petroleum from soils.

Soil remediation can be achieved using biological techniques. This method is called bioremediation. Some examples of bioremediation techniques include:

- Phytoremediation: The use of plants to remove contaminants from soils or to degrade contaminants to a lesser toxic form. Some plants have the ability to extract contaminants from soils. This process is called phytoextraction.
- The willow (Salix viminalis) is a shrub credited for its ability to extract cadmium from soils.

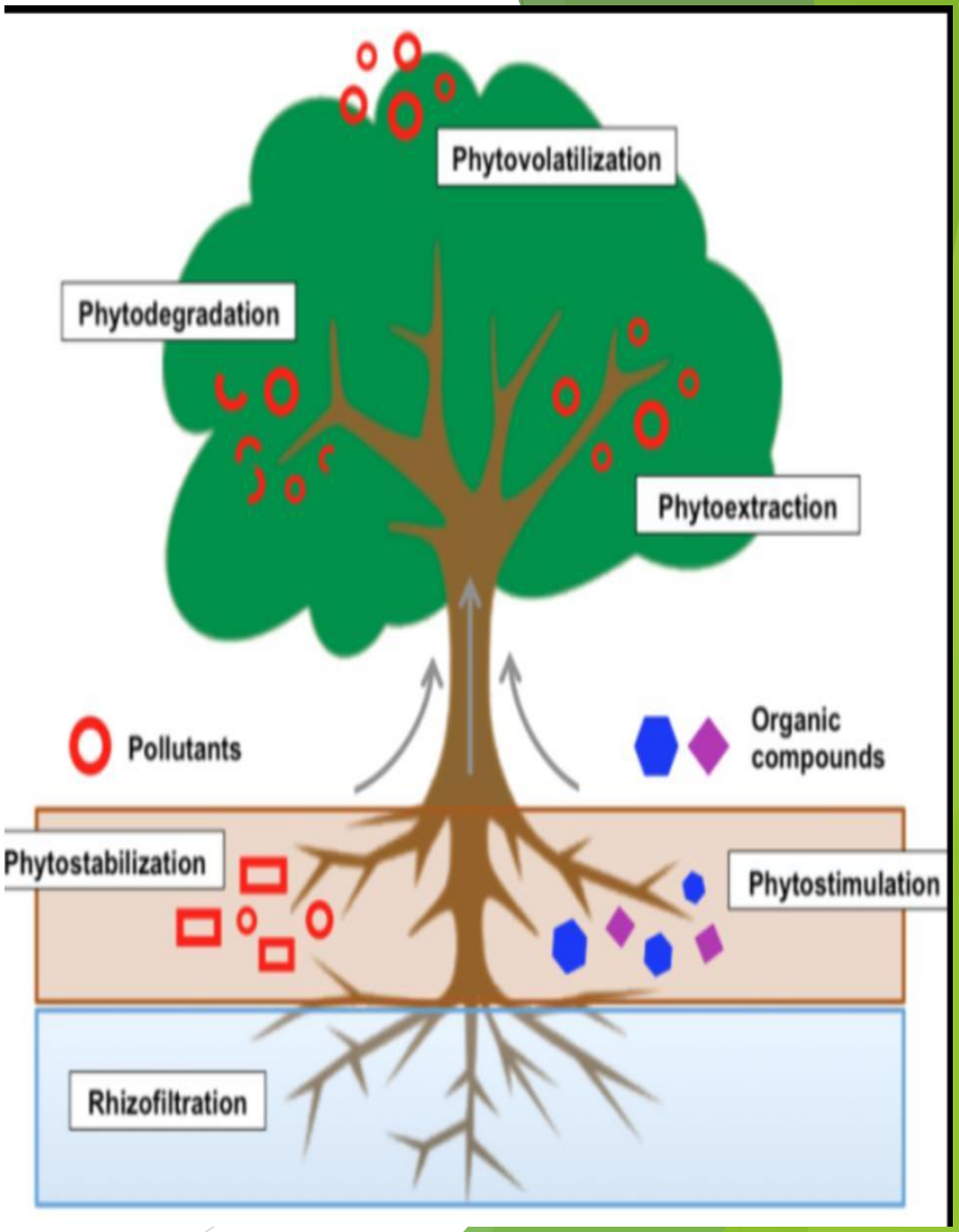
- Phyto-extraction is one technique in phytoremediation. Some other techniques are phyto-stabilization, phyto-transformation and phyto-stimulation.

❖ Bioaugmentation:

- This is the introduction of genetically modified micro-organisms into contaminated soils with the aim of degrading contaminants.
- The efficiency of this technique depends on a number of factors, some of which are the physico-chemical properties of the soil and the ability of the introduce micro-organismsms to compete successfully with the indigenous soil microflora

❖ Land-based treatments:

- This includes techniques like land farming and composting. In land farming. contaminated soils are taken to land farming sites and continuously overturned and tilled to allow aeration. In composting micro-organismsms present in organic material are used to biodegrade soil contaminants



Desalinization:

- Soil salinization occurs when high levels of soluble salts accumulate in the root zone. Saline soils frustrate crop growth and reduce crop yleld. Soll salinization is encouraged by
- Formation from parent materials with high salt content
- Low rainfall in arid regions where there is insufficient water to leach salts
- Poor soil drainage system
- Excessive exposure of soil to salty irrigation water or chemicals

Some methods used to restore saline soils are:

- Installing drainage systems to wash salts down the soil profile (this method is expensive and complicated).
- Leaching out saline soils by applying water to contaminated soils to wash salts beyond the root zone.

Use of salt tolerant plants (halophytes) as bio-remediants:

- Halophytes accumulate salts in their shoots and other aerial plant parts.

Examples include 1.Allenrolea occidentalis (iodine bush), 2.Salicornia bigelovii (dwarf saltwort), 3.Panicum virgatum (switch grass), 4. Sesuvium portulacastrum (sea purslane).

• Application of gypsum (calcium sulphate dehydrate) to sodic soils. Sodic soils have high content of sodium chloride.

Gypsum mixed into the layers of sodic soils replaces sodium with calcium, reducing the sodium level

CONCLUSION

- 1. More than 6-7 million hectare of land are degraded annually and increasing per year due to improper management and ever increasing demand and increasing population which should be controlled with proper restoration technology and creating awareness towards land use planning.
- 2.Traditional methods of restoration can be used for small area to restore land.
- 3. Large effected degraded land are hard to restore and are much more expensive.

FINAL REMARK-ITS BETTER TO TAKE CARE OF SOIL AND LAND BEFORE ITS GET LATE TO RECOVER.